

DISCRETE CHOICE MODELING OF ENVIRONMENTAL SECURITY

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## EXECUTIVE SUMMARY

### DISCRETE CHOICE MODELING OF ENVIRONMENTAL SECURITY

The presence of overpopulation or unsustainable population growth may place pressure on the food and water supplies of countries in sensitive areas of the world. Severe air or water pollution may place additional pressure on these resources. These pressures may generate both internal and international conflict in these areas as nations struggle to provide for their citizens. Such conflicts may result in United States intervention, either unilaterally, or through the United Nations. Therefore, it is in the interests of the United States to identify potential areas of conflict in order to properly train and allocate forces. The purpose of this research is to forecast the probability of conflict in a nation as a function of its environmental conditions.

Probit, logit and ordered probit models are employed to forecast the probability of conflict and the probability of a given level of conflict. Data from 95 countries is used to estimate the models. Probability forecasts are generated for these 95 nations. Out-of sample forecasts are generated for an additional 22 nations. These probabilities are then used to rank nations from highest probability of conflict to lowest. The results indicate that the dependence of a nation's economy on agriculture, the rate of deforestation, and population density are important variables in forecasting the probability and level of conflict.

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## ABSTRACT

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## I. INTRODUCTION

The presence of overpopulation or unsustainable population growth may place pressure on the food and water supplies of countries in sensitive areas of the world such as the Middle East, Africa, South and Southeast Asia, Eastern Europe, and the former Soviet Republics. Severe air or water pollution may place additional pressure on these resources. These pressures may generate both internal and international conflict in these areas as nations struggle to provide for their citizens. Such conflicts may result in United States intervention, either unilaterally, or through the United Nations. Therefore, it is in the interests of the United States to identify potential areas of conflict in order to properly train and allocate forces. The purpose of this research is to forecast the probability of conflict in a nation as a function of its environmental conditions.

Three limited-dependent variable models, probit, logit and ordered probit, are employed to forecast the probability of conflict (probit and logit models) and the probability of a given level of conflict (LOW, MODERATE, HIGH, or VERY HIGH – in the ordered probit models). Data from 95 countries is used to estimate the models. Probability forecasts are generated for these 95 nations as well as out-of sample forecasts for an additional 22 nations. These probabilities are then used to rank nations from highest probability of conflict to lowest. The following countries consistently fall in the top ten countries with the highest probability of conflict, regardless of the modeling technique employed: Angola, Ethiopia, Myanmar, Uganda, Ghana, Cambodia, Laos, and Somalia. These results are not surprising. The results indicate that the dependence of a nation's economy on agriculture, the rate of deforestation, and population density are important variables in forecasting the probability and level of conflict.

It is clear that environmental variables do play a role in generating or exacerbating conflict. It is unclear that the United States military has any direct role in mitigating the environmental conditions that may generate conflict. A more important role for the military is to aid in data gathering to generate better forecasts so that troops are adequately prepared when conflict arises.

## **II. BACKGROUND**

Recent research in political science and international relations has established links between environmental scarcity and intra- and international conflicts<sup>1</sup>. Most of this research has focused on the analysis of case studies and use of correlational techniques such as the Pearson's Chi-Squared Test to identify the relationships between environmental variables and development of conflict<sup>2</sup>. Because the route between environmental stress and conflict is usually circuitous and indirect<sup>3</sup>, this research is important in developing an understanding of how environmental scarcity leads to conflict. However, because the data in case studies necessarily occurred in the past, it is difficult to use such data to forecast the current potential for conflict, as environmental or political conditions, or both, may have changed.

Maxwell and Reuveny (1998) draw on the case-study research to develop a theoretical model that relates resource dynamics, population dynamics, and conflict. The model is a modification of Brander and Taylor's (1998) dynamic predator-prey model of population growth and renewable resource use. This model provides an explanation for population crashes such as that of the society on Easter Island. Maxwell and Reuveny establish a steady state equilibrium between the population and resource use. They then demonstrate that an exogenous shock to the system may force it into a "conflict zone" (p.

12). This conflict zone is characterized by low levels of per capita resources. They show that it is possible for the country to cycle between conflict and peace as it returns to the steady state following the shock.

This dynamic model establishes the basis for the determination of the independent variables that will be used to predict conflict. The variables are intended to be indicators of the degree of pressure that a nation's population is placing on its resources and may indicate a nation's vulnerability to a shock that may push it into Maxwell and Reuveny's so-called conflict zone. The following section describes the econometric models used to predict conflict. Section IV contains a description of the data and sources. Section V presents the results followed by some policy recommendations and conclusions in Section VI.

### **III. LIMITED-DEPENDENT VARIABLE ECONOMETRIC MODELS**

The level of threat or the potential for conflict that a nation poses is a latent, or unobserved variable in that it is not directly measurable on a continuous scale. It is possible, however, to construct indicator variables to represent the underlying latent threat variable. The construction of such variables is the principle behind limited-dependent variable models in econometrics. In the simplest case, the indicator variable is a binary variable of the form: 0 if a country is not a threat, 1 if a country is a threat. If we allow  $y^*$  to represent the latent variable measuring actual threat, and  $y$  to be the binary indicator variable, then values are assigned to  $y$  as follows:

$$\begin{aligned} y &= 0 \text{ if } y^* \leq 0 \\ y &= 1 \text{ otherwise} \end{aligned} \tag{1}$$

where the true underlying model for  $y^*$  is:

$$y^* = \beta'X + \varepsilon \quad (2)$$

$y^*$  is an  $n \times 1$  vector of the threat that a country poses,  $X$  is an  $n \times k$  matrix of explanatory variables, in this case variables reflecting the level of environmental stress in a nation,  $\beta$  is a  $k \times 1$  vector of parameters that indicate the effect of the explanatory variables on the level of conflict, and  $\varepsilon$  is an  $n \times 1$  vector of error terms reflecting individual deviations from mean behavior in the population. If it were possible to observe  $y^*$ , one could simply run a standard linear regression using ordinary least squares (OLS) to determine the values of the coefficients. However, because the observed indicator variable is discrete, OLS is not applicable. Two models are common. If  $\varepsilon$  is assumed to have a standard normal distribution, then a probit model is estimated. If  $\varepsilon$  is assumed to have an extreme value distribution, then a logit model is appropriate. In either case, a likelihood function is specified that describes the probability of  $y$  given the values of the explanatory variables. Maximum likelihood estimation is then used to estimate the coefficients.<sup>4</sup>

In many cases the indicator can take on a number of discrete values, indicating the level of threat or conflict that a nation poses. The underlying model for the latent variable is the same, but the indicator variable takes the form:

$$\begin{aligned} y &= 0 \text{ if } y^* \leq 0 \\ y &= 1 \text{ if } 0 < y^* \leq \mu_1 \\ y &= 2 \text{ if } \mu_1 < y^* \leq \mu_2 \\ &\vdots \\ y &= J \text{ if } \mu_{J-1} < y^* \end{aligned} \quad (3)$$

If the assumption is that the error terms have a standard normal distribution, which is typically the case, then the model is an ordered probit model. As in the binary probit

model, the likelihood function is specified and the parameters are computed using maximum likelihood estimation.

Three models are estimated for this research. In the first two, probit and logit, the dependent variable is either 0, no threat of conflict, or 1 a threat of conflict. In the third model, the dependent variable is a discrete variable ranging from 0 to 3, where 0 represents low threat of conflict and 3 represents a very high threat of conflict. The following section describes the data used for both the dependent and independent variables in the model.

#### **IV. DATA**

The dependent variable data is the Coplin-O'Leary 18-month and 5 year risk of turmoil in a country, from Political Risk Services (PRS), a provider of international data to businesses and research institutions. The term turmoil refers to, "...large-scale protests, general strikes, demonstrations, riots, terrorism, guerrilla warfare, civil war, and cross-border war. It also includes turmoil caused by a government's reaction to unrest."<sup>5</sup> Political Risk Services rates the risk of turmoil as either LOW, MODERATE, HIGH, or VERY HIGH. These ratings are useful because it is straightforward to translate them into binary and discrete variables for the logit, probit, and ordered probit models. In addition, the criteria that PRS uses to classify a country according to turmoil risk are comparable to the stages of conflict posited by Jongman (1994). Table 1 reports a comparison of the PRS and Jongman classifications of conflict.

Table 1. Comparison of Conflict Definitions

PRS Category	Jongman Classification
<b>LOW</b> <ul style="list-style-type: none"> <li>• Most discontent is expressed peacefully</li> <li>• Violence from political causes is extremely rare</li> </ul>	<b>Stable Social System</b> <ul style="list-style-type: none"> <li>• High degrees of political stability and regime legitimacy</li> </ul>
<b>MODERATE</b> <ul style="list-style-type: none"> <li>• May be affected by occasional riots, acts of terrorism, and significant levels of labor unrest or other kinds of discontent</li> </ul>	<b>Political Tension Situation</b> <ul style="list-style-type: none"> <li>• Growing levels of systemic frustration and increasing social and political cleavages along sectarian identities</li> </ul>
<b>HIGH</b> <ul style="list-style-type: none"> <li>• Levels of violence or potential violence that could seriously affect international business</li> </ul>	<b>Serious Dispute Stage</b> <ul style="list-style-type: none"> <li>• Erosion of political legitimacy of the national government and rising acceptance of sectarian politics</li> </ul>
<b>VERY HIGH</b> <ul style="list-style-type: none"> <li>• The level of turmoil approaches a state of war</li> </ul>	<b>Lower Intensity Conflict</b> <ul style="list-style-type: none"> <li>• Open hostility and armed conflict among factional groups; regime repression and insurgency</li> </ul>
(Source: <a href="http://www.countrydata.com/polriskrating.html">http://www.countrydata.com/polriskrating.html</a> )	<b>High Intensity Conflict</b> <ul style="list-style-type: none"> <li>• Open warfare among rival groups</li> </ul> (Source: Jongman (1994), Appendix 1)

The PRS data is transformed into binary and discrete dependent variables. For the binary dependent variable, a country receives a score of 0 (no risk) if either the 18-month or 5-year PRS turmoil risk rating is LOW. Otherwise, the country receives a score of 1. This dependent variable is employed in the estimation of the logit and probit models. The discrete dependent variable corresponds to the PRS turmoil risk levels as follows: 0 = LOW, 1 = MODERATE, 2 = HIGH, 3 = VERY HIGH. Because the discrete dependent variable has a finer gradient, it includes more information. This additional information should result in a more accurate forecast.

The dependent variables are chosen to reflect the level of stress on a nation's environment. Homer-Dixon (1994) posits six types of environmental change that are plausible sources of conflict. They are:

1. greenhouse-induced climate change
2. stratospheric ozone depletion
3. degradation and loss of good agricultural land
4. degradation and removal of forests
5. depletion and pollution of fresh water supplies
6. depletion of fisheries<sup>6</sup>

Because the data on the first two sources is more global in nature, it is difficult to measure their effects on a given country. Therefore, independent variables that focus on the final four sources of conflict are included in the model. The variables were obtained from numerous sources, such as the World Resources Institute, the United Nations Population Fund, and the World Food Programme. Data from 95 countries is employed in the estimation of the model. Forecasts are generated for these 95 countries, plus out-of-

sample forecasts for 22 additional countries. The ready availability of data over the internet made the construction of the data set a straightforward process. Availability of internet data should be a boon to future research in this area. Table 2 reports the definitions of the independent and dependent variable data, as well as their sources. Table 3 lists the countries included in the data set. Table 4 reports descriptive statistics of the variables, and Table 5 reports the correlation matrix of the variables.

## V. REGRESSION RESULTS

Table 6 reports the results of the probit estimation. The coefficients from the probit model are not directly interpretable. Rather, the marginal effects of the independent variables, which are reported in the table, are the key indicators of the effect of the environmental variables on the probability of conflict. These marginal effects are the effect of a change in the independent variable on the probability of conflict, evaluated at the margin. The two significant variables are the percent of Gross Domestic Product from agriculture and the rate of deforestation. Dependence of an economy on agriculture increases the probability of conflict. If an economy is dependent on agriculture, it is more vulnerable to shocks. Such shocks may then push a country into the conflict zone, as in Maxwell and Reuveny (1998). The effect of deforestation on conflict is actually the opposite of what Homer-Dixon (1994) and others have predicted. These results indicate that as deforestation increases, the probability of conflict falls. This counterintuitive result stems from the fact that most countries with high conflict ratings have negative rates of deforestation (negative *deforestation* = net *increase* in forest area). Perhaps this is indicative of the fact that deforestation is not a major environmental problem. Another possibility is that this measure of deforestation, percent change in total forest area is

Table 2. Data Definitions and Sources

Variable Name	Definition	Source
THREATB	Binary threat variable 0 if either 18-month or 5-year turmoil risk classification is LOW	Political Risk Services
THREAT18	0 = LOW 1 = MODERATE 2 = HIGH 3 = VERY HIGH 18-month risk of turmoil	Political Risk Services
THREAT5	0 = LOW 1 = MODERATE 2 = HIGH 3 = VERY HIGH 5-year risk of turmoil	Political Risk Services
POPG90_95	Average annual change in population (%), 1990-1995	<i>World Resources 1996-97</i> , Table 8.1
POPG00_05	Average annual projected change in population (%), 2000-2005	<i>World Resources 1996-97</i> , Table 8.1
POPDENS	Population per 1000 hectares, 1995	<i>World Resources 1996-97</i> , Table 9.1
POPARAB	Population per hectare of arable land	United Nations Population Fund, <i>State of the World Population 1998</i>
FOODAID	Total food aid deliveries 1997 (1000 tons)	World Food Programme
AGGDP	% of Gross Domestic Product from agriculture, 1993	<i>World Resources 1996-97</i> , Table 7.1
DEFOREST	Annual % change in forest and other wooded land 1981-90 (For Europe, Canada and Australia, Annual % change in total forest, 1981-90) Values for USSR used for the Central Asian Republics and Russia Values for Yugoslavia used for Bosnia, Croatia, and Macedonia,	<i>World Resources 1996-97</i> , Table 9.2
ENGIMP	Net commercial energy imports as a % of consumption, 1993	<i>World Resources 1996-97</i> , Table 12.2
H2OUSE	Annual withdrawals of water as a % of annual internal renewable water resources	<i>World Resources 1996-97</i> , Table 13.1
FLOW	Annual river flows from other countries (cubic km)	<i>World Resources 1996-97</i> , Table 13.1

Table 3. Countries in Data Set

Countries Used in Estimation				
<u>Africa</u> Algeria Botswana Cameroon Congo Cote d'Ivoire Egypt Gabon Ghana Guinea Kenya Libya Morocco Nigeria South Africa Sudan Tunisia Zaire Zambia Zimbabwe	<u>Europe</u> Austria Belgium Bulgaria Czech Republic Denmark Finland France Germany Greece Hungary Ireland Italy Netherlands Norway Poland Portugal Romania Russia Spain Sweden Switzerland Ukraine United Kingdom	<u>North &amp; Central America</u> Canada Costa Rica Cuba Dominican Republic El Salvador Guatemala Haiti Honduras Jamaica Mexico Nicaragua Panama Trinidad & Tobago  <u>South America</u> Argentina Bolivia Brazil Chile Colombia	Ecuador Guyana Paraguay Peru Suriname Uruguay Venezuela  <u>Asia</u> Bangladesh China India Indonesia Iran Iraq Israel Japan Korea, South Kuwait Malaysia Myanmar Oman Pakistan Philippines Saudi Arabia	Singapore Sri Lanka Syria Thailand Turkey United Arab Emirates Vietnam Yemen  <u>Oceania</u> Australia New Zealand Papua New Guinea
Out-of-Sample Forecast Countries				
<u>Africa</u> Central African Republic Eritrea Ethiopia Rwanda Somalia Uganda	<u>Europe</u> Bosnia Croatia Macedonia Yugoslavia	<u>Middle East</u> Afghanistan Jordan Lebanon	<u>Former Soviet Central Asian Republics</u> Kazakhstan Kyrgyzstan Tajikistan Tukmenistan Uzbekistan	<u>Asia</u> Cambodia Korea, North Laos Nepal

Table 4. Descriptive Statistics of Variables

Variable	Mean	Standard Deviation
THREATB	0.5368	0.5013
THREAT18	0.9263	0.9253
THREAT5	0.8526	0.8748
POPG90_95	1.6705	1.4660
POPG00_05	1.4726	1.0718
POPDENS	1504.0632	4869.0685
POPARAB	3.3553	8.2816
ENGIMP	-104.3602	493.2578
FOODAID	31.0232	83.8367
AGGDP	15.9033	12.6748
DEFOREST	-0.5838	1.1752
H2OUSE	27.3025	86.4736
FLOW	118.6035	253.2984

Table 5. Correlation Matrix of Variables

	THREATB	THREAT18	THREAT5	POPG90_95	POPG00_05	POPDENS	
THREATB	1.0000						
THREAT18	0.9131	1.0000					
THREAT5	0.8844	0.8999	1.0000				
POPG90_95	0.7334	0.7249	0.6803	1.0000			
POPG00_05	0.7626	0.7662	0.7656	0.8847	1.0000		
POPDENS	0.1300	0.1188	0.1204	0.1681	0.1604	1.0000	
POPARAB	0.3035	0.3268	0.3170	0.4179	0.4639	0.1592	
ENGIMP	-0.2470	-0.2422	-0.2538	-0.2711	-0.3631	0.0463	
FOODAID	0.4121	0.3703	0.3412	0.3643	0.3903	0.2109	
AGGDP	0.7680	0.7416	0.7424	0.7682	0.8030	0.1653	
DEFOREST	-0.5043	-0.5361	-0.3906	-0.4457	-0.5022	-0.1155	
H2OUSE	0.2329	0.1602	0.2508	0.3223	0.3493	0.0767	
FLOW	0.4292	0.3652	0.4458	0.3439	0.3589	0.1058	
	POPARAB	ENGIMP	FOODAID	AGGDP	DEFOREST	H2OUSE	FLOW
POPARAB	1.0000						
ENGIMP	-0.1814	1.0000					
FOODAID	0.1960	-0.1642	1.0000				
AGGDP	0.3417	-0.1448	0.5026	1.0000			
DEFOREST	-0.2385	0.0481	-0.2675	-0.4171	1.0000		
H2OUSE	0.0890	-0.1332	0.0535	0.2233	0.1608	1.0000	
FLOW	0.1223	-0.0889	0.4320	0.3715	-0.2537	0.0296	1.0000

flawed. Perhaps this measure reflects older, larger trees being replaced with smaller, younger trees. A measure such as change in total board feet of forest, or change in a specific type of forest, such as old growth or hardwood, may be more appropriate. However, data on these variables is currently sparse at best. The likelihood ratio statistic,  $\lambda$ , for the test that the model has no explanatory power is 42.96. This value is significant at levels well below 1%.

Table 7 reports the logit results. These results closely mirror the probit model results. This result is not uncommon. For well-behaved data, the logit and probit models generate very similar results. There is no compelling reason to choose one model over the other. As in the probit results, the marginal effects of the independent variable on the probability of conflict are reported. One should note, however, that they are just a constant multiple (in this case 0.25) of the logit coefficients. This is a feature of the logit model. The marginal effects in the two models are identical in sign for all variables and similar in magnitude. As in the probit model, percentage of GDP from agriculture and the rate of deforestation are the significant variables. The likelihood ratio statistic for the test that the model has no explanatory power is 42.7, which is significant at any standard level.

Tables 8 and 9 report the results for the 18-month and 5 year ordered probit models, respectively. In these models, the significant variables have changed. The rate of deforestation still has a negative effect on conflict in the 18-month model, but it is not significant in the 5-year model. In addition, the percent of GDP from agriculture is not significant in the 18-month model. In the 5-year model, the effect of the percent of GDP from agriculture is only significant at the 10% level. Furthermore, population density has a negative effect on conflict. This result reflects the fact that many developed countries,

Table 6. Probit Model Results

Variable	Coefficient	Standard. Error	Marginal Effect	t-statistic	p-value
CONSTANT	<b>-0.9895</b>	<b>0.3944</b>	<b>-0.2419</b>	<b>-2.5089</b>	<b>0.0121</b>
POPG90 95	0.2124	0.2380	0.0796	0.8922	0.3723
POPG00 05	-0.1691	0.3290	-0.0654	-0.5139	0.6074
POPDENS	-0.0003	0.0002	-0.0001	-1.3534	0.1759
POPARAB	-0.0114	0.0171	-0.0045	-0.6649	0.5061
ENGIMP	-0.0009	0.0007	-0.0004	-1.2616	0.2071
FOODAID	0.0050	0.0046	0.0020	1.086	0.2775
AGGDP	<b>0.0490</b>	<b>0.0191</b>	<b>0.0144</b>	<b>2.5654</b>	<b>0.0103</b>
DEFOREST	<b>-0.3852</b>	<b>0.1579</b>	<b>-0.1499</b>	<b>-2.4391</b>	<b>0.0147</b>
H2OUSE	0.0015	0.0019	0.0006	0.7710	0.4407
FLOW	0.0006	0.0007	0.0002	0.8224	0.4108
Log Likelihood = -44.11 $\lambda=42.96$ , $p < 0.005$					

Table 7. Logit Model Results

Variable	Coefficient	Standard. Error	Marginal Effect	t-statistic	p-value
CONSTANT	<b>-1.6153</b>	<b>0.6629</b>	<b>-0.4038</b>	<b>-2.4370</b>	<b>0.0148</b>
POPG90 95	0.3940	0.4778	0.0985	0.8245	0.4097
POPG00 05	-0.3226	0.6075	-0.0807	-0.5309	0.5955
POPDENS	-0.0005	0.0004	-0.0001	-1.3872	0.1654
POPARAB	-0.0196	0.0281	-0.0049	-0.6961	0.4864
ENGIMP	-0.0014	0.0012	-0.0004	-1.1672	0.2431
FOODAID	0.0082	0.0077	0.0021	1.0766	0.2816
AGGDP	<b>0.0841</b>	<b>0.0337</b>	<b>0.0210</b>	<b>2.4961</b>	<b>0.0126</b>
DEFOREST	<b>-0.6338</b>	<b>0.2626</b>	<b>-0.1585</b>	<b>-2.4133</b>	<b>0.0158</b>
H2OUSE	0.0023	0.0031	0.0006	0.7569	0.4491
FLOW	0.0009	0.0011	0.0002	0.8004	0.4235
Log Likelihood = -44.24 $\lambda = 42.70$ , $p < 0.005$					

Table 8. Ordered Probit Results – 18-Month Conflict Risk

Variable	Coefficient	Standard Error	t-statistic	p-value
<b>CONSTANT1</b>	<b>1.1235</b>	<b>0.1965</b>	<b>5.7161</b>	<b>0.0000</b>
<b>CONSTANT2</b>	<b>2.3822</b>	<b>0.3167</b>	<b>7.5230</b>	<b>0.0000</b>
POPG90 95	0.1262	0.2093	0.6032	0.5464
POPG00 05	-0.0083	0.2816	-0.0297	0.9763
<b>POPDENS</b>	<b>-0.0004</b>	<b>0.0002</b>	<b>-2.5031</b>	<b>0.0123</b>
POPARAB	-0.0028	0.0132	-0.2156	0.8293
ENGIMP	-0.00002	0.0005	-0.0385	0.9693
FOODAID	0.0048	0.0036	1.3230	0.1858
AGGDP	0.0203	0.0130	1.5596	0.1188
<b>DEFOREST</b>	<b>-0.3317</b>	<b>0.1456</b>	<b>-2.2781</b>	<b>0.0227</b>
H2OUSE	-0.0001	0.0015	-0.0974	0.9224
FLOW	-0.000008	0.0006	-0.1394	0.8891
Log Likelihood = -95.58 $\lambda = 30.72$ , $p < 0.005$				

Table 9. Ordered Probit Results – 5-Year Conflict Risk

Variable	Coefficient	Standard Error	t-statistic	p-value
<b>CONSTANT1</b>	<b>1.5368</b>	<b>0.2482</b>	<b>6.1917</b>	<b>0.0000</b>
<b>CONSTANT2</b>	<b>2.3035</b>	<b>0.3420</b>	<b>6.7348</b>	<b>0.0000</b>
POPG90 95	-0.1074	0.1985	-0.5411	0.5884
POPG00 05	0.2666	0.2771	0.9623	0.3359
<b>POPDENS</b>	<b>-0.0002</b>	<b>0.0001</b>	<b>-2.2140</b>	<b>0.0268</b>
POPARAB	-0.0030	0.0132	-0.2271	0.8203
ENGIMP	-0.00007	0.0003	-0.2180	0.8274
FOODAID	0.0014	0.0031	0.4560	0.6484
<b>AGGDP</b>	<b>0.0244</b>	<b>0.0139</b>	<b>1.7582</b>	<b>0.0787</b>
DEFOREST	-0.0545	0.1565	-0.3478	0.7280
H2OUSE	0.0004	0.0019	0.2018	0.8401
FLOW	0.0008	0.0007	1.0484	0.2944
Log Likelihood = -94.85 $\lambda = 41.10$ , $p < 0.005$				

such as those in Western Europe, tend to be highly urbanized. These countries are also relatively peaceful. The likelihood ratio statistics for the 18-month and 5-year models are 30.72 and 41.10, respectively. These statistics are sufficient to reject the hypothesis that the model has no explanatory power at any standard level of significance.

These models mirror other models that have examined the correlation between socioeconomic variables and conflict in that there is no clear correlation between the two, and the correlation is often the opposite of what intuition would imply.<sup>7</sup> In addition, they find generally weak relationships between environmental variables and conflict. These results probably occur because environmental conditions may tend to exacerbate or accelerate existing conflicts, rather than generate conflict directly.<sup>8</sup>

These models can be used to generate forecasted probabilities of conflict for countries both in and outside the sample. Forecasts are computed for 117 countries. For the logit and probit models, the forecasted probability of conflict is computed. For the ordered probit models, the 18-month and 5-year probability that a country falls within a given conflict class (LOW, MODERATE, HIGH, or VERY HIGH) is computed for each country, conflict class, and time period. The result is 10 forecasted probabilities for each country. A complete listing of all of the probabilities is in the Appendix. Table 10 reports the 10 countries which have the highest probability of conflict from the logit and probit models, as well as the highest probability of falling in conflict class VERY HIGH in 18 months and 5 years for the ordered probit models. It is important to note that many of the countries that appear in the last two columns have relative low probabilities of VERY HIGH conflict. In fact, many of these countries have a higher probability of HIGH or

Table 10. Ten Countries with Highest Risk of Conflict

(Probabilities in Parentheses)

Probability of Conflict (Probit)	Probability of Conflict (Logit)	Probability of Conflict Class 3 (VERY HIGH) 18-Month	Probability of Conflict Class 3 (VERY HIGH) 5-Year
1. Angola (1.0000)	1. Angola (0.9997)	1. Ethiopia (0.7967)	1. Ethiopia (0.5094)
2. Ethiopia (0.9999)	2. Ethiopia (0.9985)	2. Angola (0.3904)	2. Somalia (0.4666)
3. Bangladesh (0.9958)	3. Myanmar (0.9874)	3. Sudan (0.3085)	3. Brazil (0.3114)
4. Myanmar (0.9941)	4. Bangladesh (0.9838)	4. Ghana (0.2821)	4. Myanmar (0.3019)
5. India (0.9871)	5. Uganda (0.9782)	5. Pakistan (0.2624)	5. Cambodia (0.2801)
6. Uganda (0.9858)	6. India (0.9776)	6. Uganda (0.2306)	6. Laos (0.2628)
7. Ghana (0.9835)	7. Ghana (0.9753)	7. Myanmar (0.2237)	7. Ghana (0.2426)
8. Cambodia (0.9826)	8. Cambodia (0.9751)	8. Nicaragua (0.2183)	8. Central African Republic (0.2419)
9. Laos (0.9747)	9. Laos (0.9684)	9. Paraguay (0.2114)	9. Angola (0.2411)
10. Somalia (0.9737)	10. Somalia (0.9663)	10. Laos (0.2095)	10. Uganda (0.2255)

MODERATE conflict. These results reflect the fact that environmental variables are more likely to generate conflict at the sub-national rather than international level.<sup>9</sup> However, some countries consistently appear in the top ten. The military may want to keep a close eye on these countries in the future.

## **VI. CONCLUSIONS AND POLICY RECOMMENDATIONS**

These results are a first attempt at using limited-dependent variable models to forecast potential environmental security threats in the future. They indicate that some environmental variables may be useful in predicting conflict. However, a complete model of conflict should include causes from non-environmental sources as well. The forecasts generated from these models seem to reflect current security conditions in various parts of the world.

It is unclear what direct role the United States military may play in mitigating the environmental conditions that may exacerbate conflicts. The U.S. military currently plays a role as the "world's policeman" in various part of the world. It is doubtful that it would be useful for it to become the world's garbage man as well. However, there are a few potential roles that the military may play. The first is as researcher. The military collects large amounts of satellite imagery that may be useful in generating more data on the decline of forests, the rate and degree of desertification, and the state of the polar ice caps. Since some of this data is classified, perhaps it is necessary to examine whether it would be useful to declassify some of this data and make it useful to researchers<sup>10</sup>. Second, the military may be able to act as a consultant to some developing countries on such things as water projects through the Army Corps of Engineers. By ensuring that these countries develop sensible resource use plans, the military may avoid involvement in conflicts in the

future. Finally, the military can certainly use this information to ensure that its troops are properly trained for possible interventions in these areas in the future.

Environmental security is a relatively new field of research. These results indicate that environmental variables can predict conflict, although their ability to do so is weak at best. As more data becomes available, a clearer picture of the role that the environment plays in conflicts will emerge.

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<sup>1</sup> Thomas Homer-Dixon's (1994) research has uncovered evidence that environmental scarcities are already contributing to violent conflicts in many parts of the developing world.

<sup>2</sup> Homer-Dixon (1996) describes the statistical techniques that international relations researchers are currently using to analyze environmental conflicts. Although he does not specifically note the use of Pearson's Chi-Squared statistics, the table in Figure 3 (page 143) is the standard set-up to conduct a Pearson's Chi-Squared test.

<sup>3</sup> In the case of Rwanda in particular, Percival and Homer-Dixon (1996) note that environmental conditions were not the direct cause of the recent conflict there. However, they did aggravate the situation. Given the severity of environmental problems, such as rapid population growth and high population density in Rwanda, they find it surprising that they did not play a stronger role in the conflict.

<sup>4</sup> For further detail on the specification of the logit and probit likelihood functions and maximum likelihood estimation, see Maddala (1983), Chapter 2 or Greene (1993), Chapter 21.

<sup>5</sup> Source: <http://www.countrydata.com/polriskrating.html>

<sup>6</sup> Thomas Homer-Dixon, "Environmental Scarcities and Violent Conflict: Evidence from Cases," *International Security* 19 (Summer 1994): 6.

<sup>7</sup> Homer-Dixon (1994, p. 26) discusses this issue.

<sup>8</sup> See, for example, Percival and Homer-Dixon's discussion of the role of environmental variables in conflict in Rwanda (1996).

<sup>9</sup> Homer-Dixon (1994), p. 6.

<sup>10</sup> *Top Guns and Toxic Whales* (1991) refers to this data.

## REFERENCES

- Brander, James A. and Taylor, M. Scott. 1998. The Simple Economics of Easter Island: A Ricardo-Malthus Model of Renewable Resource Use. *American Economic Review* 88 (March): 119-138.
- Doan, Thomas A. 1996. *RATS, Version 4.2*. Evanston, IL: Estima.
- Greene, William H. 1993. *Econometric Analysis, Second Edition*. New York: Macmillan Publishing Company.
- Homer-Dixon, Thomas. 1994. Environmental Scarcities and Conflict: Evidence from Cases. *International Security* 19 (Summer): 5-40.
- \_\_\_\_\_. 1996. Strategies for Studying Causation in Complex Ecological-Political Systems. *Journal of Environment and Development* 5 (June): 132-148.
- Jongman, Albert. 1994. The PIOOM Program on Monitoring and Early Warning of Humanitarian Crises. *Journal of Ethno-Development* 4 : 65-71.
- Maddala, G.S. 1983. *Limited Dependent and Qualitative Variables in Econometrics*. Cambridge: Cambridge University Press.
- Maxwell, John W. and Reuveny, Rafael. 1998. *Resource Scarcity and Conflict: An Economic Analysis*. presented as part of the session "Environment and Development VIII: Rural Conflict and Poverty" at the World Congress of Environmental and Resource Economists, Venice, Italy, 25-27 June.
- Percival, Val and Homer-Dixon, Thomas. 1996. Environmental Scarcity and Violent Conflict: The Case of Rwanda. *Journal of Environment and Development* 5 (September): 270-291.
- Political Risk Services. *Turmoil Risk Ratings*. [www.prsgroup.com](http://www.prsgroup.com).
- Top Guns and Toxic Whales*. 1991. Directed by Lawrence Moore. 52 min. Videocassette.
- United Nations Population Fund. 1998. *State of the World Population 1998*. [www.unfpa.org/swp.swp98/pdf/files.htm](http://www.unfpa.org/swp.swp98/pdf/files.htm)
- World Food Programme. 1997. *WFP in Statistics 1997*. [www.unicc.org/wfp/reports/wfpstats/97/tabs5-97.html](http://www.unicc.org/wfp/reports/wfpstats/97/tabs5-97.html)
- The World Resources Institute, et. al. 1996. *World Resources 1996-97*. New York: Oxford University Press.

## APPENDIX

	Pr(Conflict) Probit	Pr(Conflict) Logit	Pr(LOW) 18-Month	Pr(MODERATE) 18-Month	Pr(HIGH) 18-Month
<b>AFRICA</b>					
Algeria	0.7186	0.7295	0.1678	0.3960	0.3583
Angola	1.0000	0.9997	0.0177	0.1457	0.4462
Botswana	0.5305	0.5343	0.2577	0.4242	0.2765
Cameroon	0.8933	0.8908	0.1602	0.3914	0.3659
Congo	0.9061	0.8914	0.2709	0.4253	0.2656
Cote d'Ivoire	0.8882	0.8960	0.0874	0.3203	0.4397
Egypt	0.8684	0.8695	0.0971	0.3335	0.4302
Gabon	0.9229	0.9034	0.2415	0.4220	0.2901
Ghana	0.9835	0.9753	0.0355	0.2121	0.4703
Guinea	0.7030	0.7255	0.1356	0.3736	0.3909
Kenya	0.8625	0.8723	0.0798	0.3089	0.4468
Libya	0.6937	0.6926	0.6893	0.2578	0.0509
Morocco	0.4544	0.4699	0.3183	0.4242	0.2294
Nigeria	0.8890	0.8881	0.2311	0.4200	0.2991
South Africa	0.3209	0.3216	0.3488	0.4200	0.2081
Sudan	0.9621	0.9551	0.0299	0.1941	0.4675
Tunisia	0.3780	0.3906	0.4682	0.3835	0.1376
Zaire	0.7280	0.7487	0.1447	0.3808	0.3815
Zambia	0.9035	0.9089	0.0836	0.3147	0.4433
Zimbabwe	0.5313	0.5528	0.2467	0.4228	0.2857
<b>EUROPE</b>					
Austria	0.1070	0.1160	0.6663	0.2735	0.0577
Belgium	0.0321	0.0419	0.9277	0.0674	0.0048
Bulgaria	0.2819	0.2851	0.5662	0.3353	0.0931
Czech	0.1374	0.1402	0.6868	0.2595	0.0516
Denmark	0.1159	0.1221	0.6944	0.2542	0.0494
Finland	0.2124	0.2185	0.4685	0.3834	0.1375
France	0.1307	0.1359	0.6486	0.2853	0.0633
Germany	0.0541	0.0644	0.8643	0.1226	0.0129
Greece	0.3780	0.3917	0.4808	0.3781	0.1313
Hungary	0.1082	0.1147	0.7269	0.2310	0.0407
Ireland	0.0983	0.1090	0.6742	0.2682	0.0553
Italy	0.0691	0.0781	0.8169	0.1618	0.0208
Netherlands	0.0191	0.0286	0.9753	0.0237	0.0010
Norway	0.3342	0.3255	0.5163	0.3616	0.1145
Poland	0.1402	0.1422	0.6740	0.2683	0.0554
Portugal	0.1020	0.1100	0.7008	0.2498	0.0476
Romania	0.4251	0.4348	0.5258	0.3568	0.1102
Russia	0.4352	0.4430	0.3682	0.4161	0.1953
Spain	0.1695	0.1739	0.5909	0.3211	0.0835
Sweden	0.1445	0.1519	0.5415	0.3487	0.1033
Switzerland	0.1019	0.1105	0.7638	0.2034	0.0318
Ukraine	0.7285	0.7522	0.3482	0.4201	0.2085
United Kingdom	0.0251	0.0361	0.9141	0.0795	0.0063
<b>NORTH AND CENTRAL AMERICA</b>					
Canada	0.2485	0.2524	0.4258	0.3997	0.1605
Costa Rica	0.7282	0.7453	0.1367	0.3746	0.3897
Cuba	0.3850	0.3940	0.4440	0.3931	0.1504

	Pr(Conflict) Probit	Pr(Conflict) Logit	Pr(LOW) 18-Month	Pr(MODERATE) 18-Month	Pr(HIGH) 18-Month
Dominican Rep.	0.6320	0.6438	0.2637	0.4248	0.2715
El Salvador	0.3144	0.3020	0.5355	0.3519	0.1059
Guatemala	0.7981	0.8105	0.1266	0.3658	0.4000
Haiti	0.9308	0.9236	0.1325	0.3710	0.3940
Honduras	0.8114	0.8245	0.0929	0.3280	0.4344
Jamaica	0.7454	0.7385	0.1595	0.3910	0.3665
Mexico	0.5005	0.5113	0.2764	0.4255	0.2613
Nicaragua	0.9263	0.9266	0.0543	0.2610	0.4664
Panama	0.5579	0.5756	0.2002	0.4110	0.3272
Trinidad & Tobago	0.2162	0.2032	0.6396	0.2911	0.0662
<b>SOUTH AMERICA</b>					
Argentina	0.3956	0.4003	0.3546	0.4189	0.2042
Bolivia	0.8610	0.8632	0.0999	0.3371	0.4273
Brazil	0.7806	0.7902	0.3467	0.4204	0.2095
Chile	0.5442	0.5651	0.3487	0.4200	0.2082
Colombia	0.6746	0.6910	0.2971	0.4255	0.2452
Ecuador	0.8068	0.8123	0.1802	0.4025	0.3462
Guyana	0.8345	0.8471	0.1794	0.4021	0.3469
Paraguay	0.9454	0.9397	0.0570	0.2668	0.4648
Peru	0.7660	0.7751	0.1443	0.3805	0.3819
Suriname	0.8487	0.8568	0.1366	0.3745	0.3898
Uruguay	0.2582	0.2645	0.4500	0.3908	0.1472
Venezuela	0.5991	0.6069	0.2718	0.4253	0.2650
<b>ASIA</b>					
Bangladesh	0.9958	0.9838	0.2723	0.4253	0.2645
China	0.4829	0.4908	0.3894	0.4109	0.1819
India	0.9871	0.9776	0.1583	0.3902	0.3678
Indonesia	0.7617	0.7779	0.2902	0.4257	0.2504
Iran	0.8006	0.8101	0.1566	0.3892	0.3694
Iraq	0.5118	0.5240	0.3162	0.4244	0.2309
Israel	0.5510	0.5772	0.5335	0.3529	0.1068
Japan	0.0608	0.0671	0.8716	0.1164	0.0118
Korea, S	0.0315	0.0402	0.9616	0.0365	0.0019
Kuwait	0.0226	0.0221	0.8324	0.1492	0.0180
Malaysia	0.8062	0.8180	0.1558	0.3886	0.3703
Myanmar	0.9941	0.9874	0.0523	0.2565	0.4674
Oman	0.4714	0.4474	0.2645	0.4248	0.2708
Pakistan	0.9687	0.9567	0.0404	0.2263	0.4709
Phillippines	0.7315	0.7392	0.2504	0.4233	0.2825
Saudi Arabia	0.5684	0.5640	0.1777	0.4013	0.3486
Singapore	0.0000	0.0000	1.0000	0.0000	0.0000
Sri Lanka	0.5603	0.5641	0.4544	0.3891	0.1448
Syria	0.3278	0.3443	0.5755	0.3300	0.0894
Thailand	0.6143	0.6216	0.2375	0.4213	0.2935
Turkey	0.4810	0.4962	0.3277	0.4232	0.2227
UAE	0.6181	0.6163	0.3215	0.4239	0.2271
Vietnam	0.6946	0.7050	0.3717	0.4153	0.1930
Yemen	0.8547	0.8669	0.1242	0.3635	0.4026

	Pr(Conflict) Probit	Pr(Conflict) Logit	Pr(LOW) 18-Month	Pr(MODERATE) 18-Month	Pr(HIGH) 18-Month
<b>OCEANIA</b>					
Australia	0.2534	0.2567	0.4135	0.4038	0.1675
New Zealand	0.3011	0.3089	0.3909	0.4105	0.1810
Papua New Guinea	0.4158	0.4308	0.2424	0.4221	0.2893
<b>OUT-OF-SAMPLE-FORECASTS</b>					
<b>AFRICA</b>					
Cent. Af. Rep.	0.9498	0.9485	0.0782	0.3063	0.4483
Eritrea	0.4455	0.4583	0.2416	0.4220	0.2900
Ethiopia	0.9999	0.9985	0.0007	0.0117	0.1849
Rwanda	0.8145	0.8197	0.3173	0.4243	0.2302
Somalia	0.9737	0.9663	0.0637	0.2805	0.4603
Uganda	0.9858	0.9782	0.0499	0.2509	0.4685
<b>EUROPE</b>					
Bosnia	0.0372	0.0427	0.7781	0.1925	0.0286
Croatia	0.1984	0.2031	0.6086	0.3105	0.0770
Macedonia	0.2285	0.2349	0.5604	0.3385	0.0954
Yugoslavia	0.7595	0.7713	0.1252	0.3645	0.4015
<b>MIDDLE EAST</b>					
Afghanistan	0.8363	0.8548	0.0592	0.2715	0.4634
Jordan	0.3906	0.4137	0.3045	0.4252	0.2395
Lebanon	0.2184	0.2218	0.6913	0.2564	0.0503
<b>FORMER SOVIET CENTRAL ASIAN REPUBLICS</b>					
Kazakhstan	0.6890	0.7125	0.2648	0.4249	0.2706
Kyrgyzstan	0.9294	0.9300	0.0984	0.3352	0.4289
Tajikistan	0.8916	0.8970	0.0855	0.3176	0.4415
Turkmenistan	0.8603	0.8687	0.1904	0.4072	0.3364
Uzbekistan	0.6053	0.6256	0.3216	0.4239	0.2270
<b>ASIA</b>					
Cambodia	0.9826	0.9751	0.0603	0.2738	0.4627
Korea, N	0.2424	0.2469	0.7039	0.2476	0.0468
Laos	0.9747	0.9684	0.0578	0.2684	0.4643
Nepal	0.8937	0.8974	0.1781	0.4015	0.3482

Pr(VERY HIGH) 18-Month	Pr(LOW) 5-Year	Pr(MODERATE) 5-Year	Pr(HIGH) 5-Year	Pr(VERY HIGH) 5-Year
<b>AFRICA</b>				
0.0779 Algeria	0.2395	0.5569	0.1483	0.0553
0.3904 Angola	0.0547	0.4198	0.2844	0.2411
0.0417 Botswana	0.2773	0.5506	0.1287	0.0434
0.0825 Cameroon	0.1233	0.5240	0.2266	0.1262
0.0382 Congo	0.1157	0.5174	0.2327	0.1341
0.1526 Cote d'Ivoire	0.0913	0.4895	0.2534	0.1659
0.1392 Egypt	0.2197	0.5578	0.1596	0.0630
0.0464 Gabon	0.2389	0.5570	0.1486	0.0555
0.2821 Ghana	0.0542	0.4184	0.2848	0.2426
0.1000 Guinea	0.1569	0.5449	0.2007	0.0974
0.1645 Kenya	0.1233	0.5240	0.2265	0.1261
0.0020 Libya	0.1220	0.5230	0.2276	0.1275
0.0281 Morocco	0.3278	0.5345	0.1060	0.0316
0.0498 Nigeria	0.1471	0.5401	0.2080	0.1048
0.0231 South Africa	0.3414	0.5290	0.1006	0.0291
0.3085 Sudan	0.0635	0.4407	0.2773	0.2185
0.0107 Tunisia	0.3108	0.5408	0.1133	0.0352
0.0930 Zaire	0.1375	0.5344	0.2153	0.1127
0.1584 Zambia	0.1127	0.5145	0.2352	0.1376
0.0448 Zimbabwe	0.2803	0.5499	0.1273	0.0426
<b>EUROPE</b>				
0.0025 Austria	0.5801	0.3788	0.0349	0.0061
0.0001 Belgium	0.7628	0.2250	0.0109	0.0013
0.0054 Bulgaria	0.4104	0.4946	0.0761	0.0189
0.0020 Czech	0.5442	0.4061	0.0418	0.0079
0.0019 Denmark	0.5889	0.3720	0.0333	0.0057
0.0106 Finland	0.4582	0.4657	0.0621	0.0140
0.0029 France	0.5612	0.3934	0.0384	0.0070
0.0002 Germany	0.7207	0.2623	0.0150	0.0019
0.0098 Greece	0.4176	0.4905	0.0739	0.0181
0.0014 Hungary	0.5329	0.4144	0.0442	0.0085
0.0023 Ireland	0.4701	0.4580	0.0590	0.0129
0.0005 Italy	0.6775	0.2996	0.0200	0.0029
0.0000 Netherlands	0.8271	0.1663	0.0060	0.0006
0.0077 Norway	0.4618	0.4634	0.0612	0.0136
0.0023 Poland	0.5306	0.4161	0.0446	0.0086
0.0018 Portugal	0.5417	0.4080	0.0423	0.0080
0.0072 Romania	0.3485	0.5259	0.0978	0.0278
0.0204 Russia	0.3434	0.5281	0.0998	0.0287
0.0045 Spain	0.5332	0.4142	0.0441	0.0085
0.0065 Sweden	0.4974	0.4396	0.0522	0.0108
0.0010 Switzerland	0.6063	0.3583	0.0304	0.0050
0.0232 Ukraine	0.2492	0.5559	0.1430	0.0519
0.0001 United Kingdom	0.7127	0.2694	0.0159	0.0020
<b>NORTH AND CENTRAL AMERICA</b>				
0.0141 Canada	0.4127	0.4932	0.0754	0.0186
0.0990 Costa Rica	0.2890	0.5476	0.1231	0.0403
0.0125 Cuba	0.4091	0.4953	0.0765	0.0191

Pr(VERY HIGH) 18-Month	Pr(LOW) 5-Year	Pr(MODERATE) 5-Year	Pr(HIGH) 5-Year	Pr(VERY HIGH) 5-Year
0.0400 Dominican Rep.	0.3856	0.5080	0.0843	0.0221
0.0067 El Salvador	0.5091	0.4314	0.0494	0.0100
0.1075 Guatemala	0.1774	0.5522	0.1863	0.0841
0.1025 Haiti	0.1724	0.5507	0.1898	0.0871
0.1448 Honduras	0.1955	0.5559	0.1744	0.0741
0.0829 Jamaica	0.4478	0.4723	0.1650	0.0149
0.0368 Mexico	0.3679	0.5169	0.0905	0.0246
0.2183 Nicaragua	0.1283	0.5280	0.2225	0.1212
0.0616 Panama	0.3360	0.5312	0.1027	0.0300
0.0031 Trinidad & Tobago	0.6033	0.3607	0.0309	0.0052
<b>SOUTH AMERICA</b>				
0.0223 Argentina	0.2922	0.5467	0.1216	0.0395
0.1356 Bolivia	0.0979	0.4982	0.2476	0.1562
0.0234 Brazil	0.0350	0.3567	0.2969	0.3114
0.0231 Chile	0.1827	0.5535	0.1828	0.0810
0.0322 Colombia	0.1731	0.5509	0.1893	0.0867
0.0711 Ecuador	0.1651	0.5482	0.1949	0.0918
0.0715 Guyana	0.0776	0.4683	0.2652	0.1889
0.2114 Paraguay	0.1103	0.5121	0.2372	0.1404
0.0933 Peru	0.1322	0.5308	0.2194	0.1175
0.0991 Suriname	0.1097	0.5115	0.2377	0.1411
0.0210 Uruguay	0.3783	0.5118	0.0868	0.0231
0.0380 Venezuela	0.2328	0.5574	0.1520	0.0578
<b>ASIA</b>				
0.0378 Bangladesh	0.2567	0.5548	0.1391	0.0495
0.0178 China	0.3592	0.5210	0.0937	0.0260
0.0837 India	0.0778	0.4688	0.2650	0.1884
0.0337 Indonesia	0.2197	0.5578	0.1596	0.0630
0.0847 Iran	0.1684	0.5494	0.1926	0.0897
0.0285 Iraq	0.1784	0.5524	0.1857	0.0835
0.0068 Israel	0.5628	0.3922	0.0381	0.0069
0.0002 Japan	0.7614	0.2263	0.0110	0.0013
0.0000 Korea, S	0.7696	0.2190	0.0103	0.0012
0.0004 Kuwait	0.1032	0.5045	0.2431	0.1491
0.0853 Malaysia	0.2391	0.5570	0.1485	0.0554
0.2237 Myanmar	0.0372	0.3650	0.2959	0.3019
0.0398 Oman	0.2980	0.5450	0.1190	0.0381
0.2624 Pakistan	0.1295	0.5289	0.2215	0.1200
0.0437 Phillippines	0.3435	0.5281	0.0998	0.0287
0.0724 Saudi Arabia	0.1895	0.5549	0.1783	0.0772
0.0000 Singapore	1.0000	0.0000	0.0000	0.0000
0.0117 Sri Lanka	0.4087	0.4955	0.0767	0.0191
0.0050 Syria	0.1752	0.5516	0.1878	0.0854
0.0477 Thailand	0.3853	0.5082	0.0844	0.0221
0.0264 Turkey	0.3424	0.5286	0.1002	0.0289
0.0275 UAE	0.3579	0.5217	0.0942	0.0262
0.0199 Vietnam	0.2741	0.5514	0.1303	0.0443
0.1098 Yemen	0.1749	0.5515	0.1880	0.0855

Pr(VERY HIGH) 18-Month	Pr(LOW) 5-Year	Pr(MODERATE) 5-Year	Pr(HIGH) 5-Year	Pr(VERY HIGH) 5-Year
<b>OCEANIA</b>				
0.0152 Australia	0.4140	0.4925	0.0750	0.0185
0.0176 New Zealand	0.4090	0.4954	0.0766	0.0191
0.0461 Papua New Guinea	0.2220	0.5578	0.1582	0.0620
<b>OUT-OT-SAMPLE-FORECASTS</b>				
<b>AFRICA</b>				
0.1673 Cent. Af. Rep.	0.0544	0.4191	0.2846	0.2419
0.0464 Eritrea	0.2516	0.5555	0.1418	0.0511
0.7967 Ethiopia	0.0100	0.2047	0.2759	0.5094
0.0283 Rwanda	0.1699	0.5499	0.1916	0.0887
0.1955 Somalia	0.0132	0.2342	0.2861	0.4666
0.2306 Uganda	0.0606	0.4342	0.2797	0.2255
<b>EUROPE</b>				
0.0001 Bosnia	0.2602	0.5542	0.1373	0.0484
0.0039 Croatia	0.4714	0.4571	0.0586	0.0128
0.0056 Macedonia	0.4426	0.4755	0.0665	0.0154
0.1088 Yugoslavia	0.3327	0.5326	0.1040	0.0307
<b>MIDDLE EAST</b>				
0.2059 Afghanistan	0.3162	0.5389	0.1109	0.0340
0.0307 Jordan	0.3648	0.5184	0.0917	0.0251
0.0020 Lebanon	0.6642	0.3109	0.0218	0.0032
<b>FORMER SOVIET CENTRAL ASIAN REPUBLICS</b>				
0.0398 Kazakhstan	0.1803	0.5529	0.1844	0.0824
0.1375 Kyrgyzstan	0.0956	0.4953	0.2496	0.1595
0.1554 Tajikistan	0.1051	0.5066	0.2416	0.1468
0.0661 Turkmenistan	0.1344	0.5324	0.2177	0.1155
0.0275 Uzbekistan	0.2031	0.5569	0.1696	0.0704
<b>ASIA</b>				
0.2032 Cambodia	0.0426	0.3843	0.2929	0.2801
0.0018 Korea, N	0.4185	0.4899	0.0736	0.0180
0.2095 Laos	0.0476	0.4000	0.2897	0.2628
0.0722 Nepal	0.1199	0.5212	0.2292	0.1296